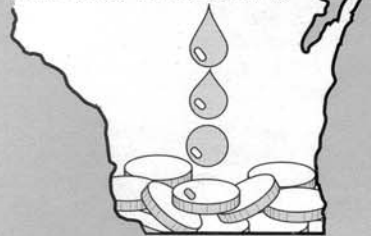


GROUNDWATER Wisconsin's buried treasure



GROUNDWATER STUDY GUIDE

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Introduction

To educators


Cool, clear water is a precious and vulnerable resource. In Wisconsin, more than 70% of us depend on groundwater for drinking. Agriculture—and thus our food supply—depends on it. Industry depends on it. Yet, until recently, most people rarely thought about this buried treasure. Today we're becoming more aware of groundwater, mainly because of increasing reports of contamination.

This study guide is designed to help you and your students begin thinking about groundwater — where it comes from, why it's important, and how it can be conserved and protected. The guide includes a brief overview of groundwater, a glossary, suggested activities, and a list of related Department of Public Instruction objectives for science, health and social studies. Also included is a list of resource publications, audio-visual materials and organizations. The guide is designed to stand alone, yet complements the *Wisconsin Natural Resources Magazine* supplement "Groundwater: Protecting Wisconsin's Buried Treasure" (see Resources).

Talk with your students before beginning your lessons to learn what they already know and think about groundwater. What is groundwater? Where does it come from? Why is it important? How can it become contaminated? How can we protect it? By learning your students' thoughts and opinions about groundwater, you can help them

connect new concepts with what they already know. We encourage you to adapt the activities to meet your students' needs. You are welcome to reproduce any part of this guide for distribution to students and other educators.

The groundwater activities are written for 6th to 9th grade Earth Science classes. Many are suitable for older or younger students and most are applicable to other subjects. Selected Wisconsin DPI objectives for science, health, and social studies are listed in the Appendix. You will find a list of relevant objectives for these subjects at the beginning of each activity: Two letters represent the subject (SC = science, EH = environmental health, SS = social studies). A single letter followed by a number corresponds to the outline in the Appendix (e.g. SC:A1 = science, objective A, subobjective 1).



Wisconsin's Buried Treasure

Picture all the water in lakes and streams in the United States. Now, try to imagine 20 times that much water hidden underground, filling cracks and pores in the earth. That's 30-60 quadrillion gallons of water within 1/2 mile of the earth's surface! However, this vast supply of groundwater isn't evenly distributed. Some areas have ample supplies of usable groundwater, other areas have little.

Wisconsin is water-rich. In fact, our state's name comes from the Chippewa word "Wees-kan-san" which means "gathering of waters." You're probably aware of the large amounts of water in our lakes and rivers, but did you know that two quadrillion gallons of water—enough to cover the entire state to a depth of 30 feet—lie hidden underground?

What is Groundwater?

Groundwater originates as rain or snow. As precipitation falls on the earth's surface, some evaporates, some runs off over land into lakes and streams and some soaks into the ground. A portion of water that enters the soil is taken up and used by plants. (A large, leafy tree can take up a ton of water in a day!) The rest percolates deeper into the earth.

Not all water found in the ground is groundwater. "Groundwater" refers specifically to water that is held in the saturated zone below the water table. Rock and soil material stores water in spaces, much like a sponge. Imagine two sponges, stacked one on top of the other. The bottom sponge has been soaked in water. It represents the "saturated zone"—all of its pore spaces are filled with water. The top sponge has been wetted, but the water has been squeezed out. This sponge represents the "unsaturated zone"—some of the spaces are filled with water, some are filled with air. The boundary between the two zones represents the "water table." The water in the saturated sponge represents groundwater.

Where is it Found?

Contrary to popular myths, groundwater doesn't flow in mysterious underground rivers nor is it stored in underground lakes. Most groundwater is found in aquifers—underground layers of porous rock and soil that are saturated with water (like a sponge). Four major aquifers underlie most of our state, but the amount and quality of water they contain is variable.

The composition of soil—clay, loam, silt, sand or rock—generally determines the amount of groundwater and the depth at which it is found in a given area. Coarse materials such as sand and gravel, which have large spaces between grains, allow for excellent storage and movement of water. On the other hand, fine-grained materials such as clay or shale restrict water movement.

Like surface water, groundwater flows from higher to lower elevations, moving through connected spaces in soil material. But, unlike water in rivers and streams, groundwater moves slowly—from a few inches to a few feet per day. Variation in rainfall and pumping from wells can affect the rate and direction of groundwater flow.

Why is it Important?

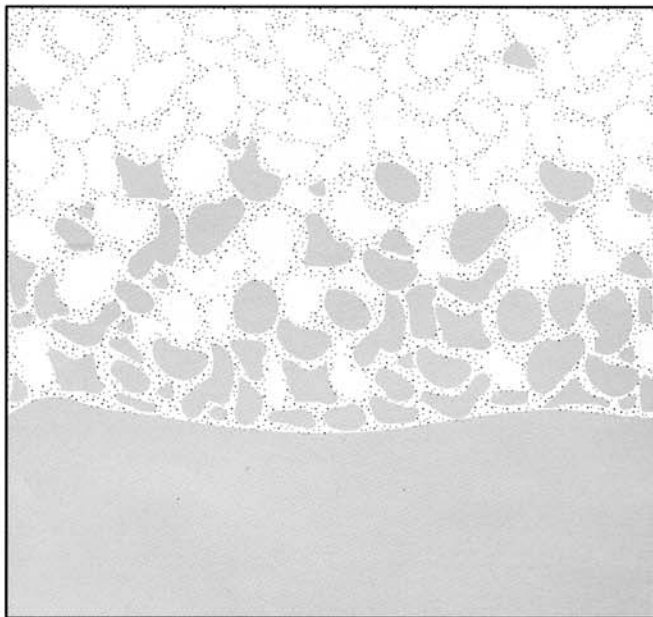
Water has helped shape Wisconsin's geography, history and industry. More than 70% of Wisconsin's homes use groundwater. An average family of four uses 255 gallons of water/day. Household use accounts for 20% of the water withdrawn from the ground in Wisconsin. Cheese, beer, papermaking and other industries also require a lot of water; Wisconsin's industries withdraw 40% of the groundwater used in the state. Commercial businesses use 7%. Thirteen percent of the water withdrawn from the ground is used for irrigation and livestock production. All together, we use almost 1/2 billion gallons of groundwater in Wisconsin each year. (see *Groundwater Supplement*, pg. 3)

Groundwater provides the base-flow for most streams and rivers and is the primary source of water for most lakes and wetlands. So it's also important to wildlife and to recreation such as fishing, boating and swimming. (See *Groundwater Supplement*, pg. 5)

Unsaturated Zone

Water Table

Saturated Zone



How Does Groundwater Become Contaminated?

Groundwater is never a pure combination of hydrogen and oxygen atoms (H_2O). As water soaks into the ground, it dissolves minerals and gases from the rock material it encounters. "Natural" groundwater contains many dissolved minerals and gases that may give it a particular taste, odor or color. Typical concentrations of most naturally-occurring contaminants pose no health risk.

Percolating groundwater can also carry human-made pollutants. Contamination can be serious if groundwater contains substances (natural or human-made) that pose a health threat—bacteria, viruses, nitrate, metals such as mercury or lead, pesticides and other synthetic organic compounds. Carelessness and lack of understanding can lead to groundwater contamination from a variety of sources including:

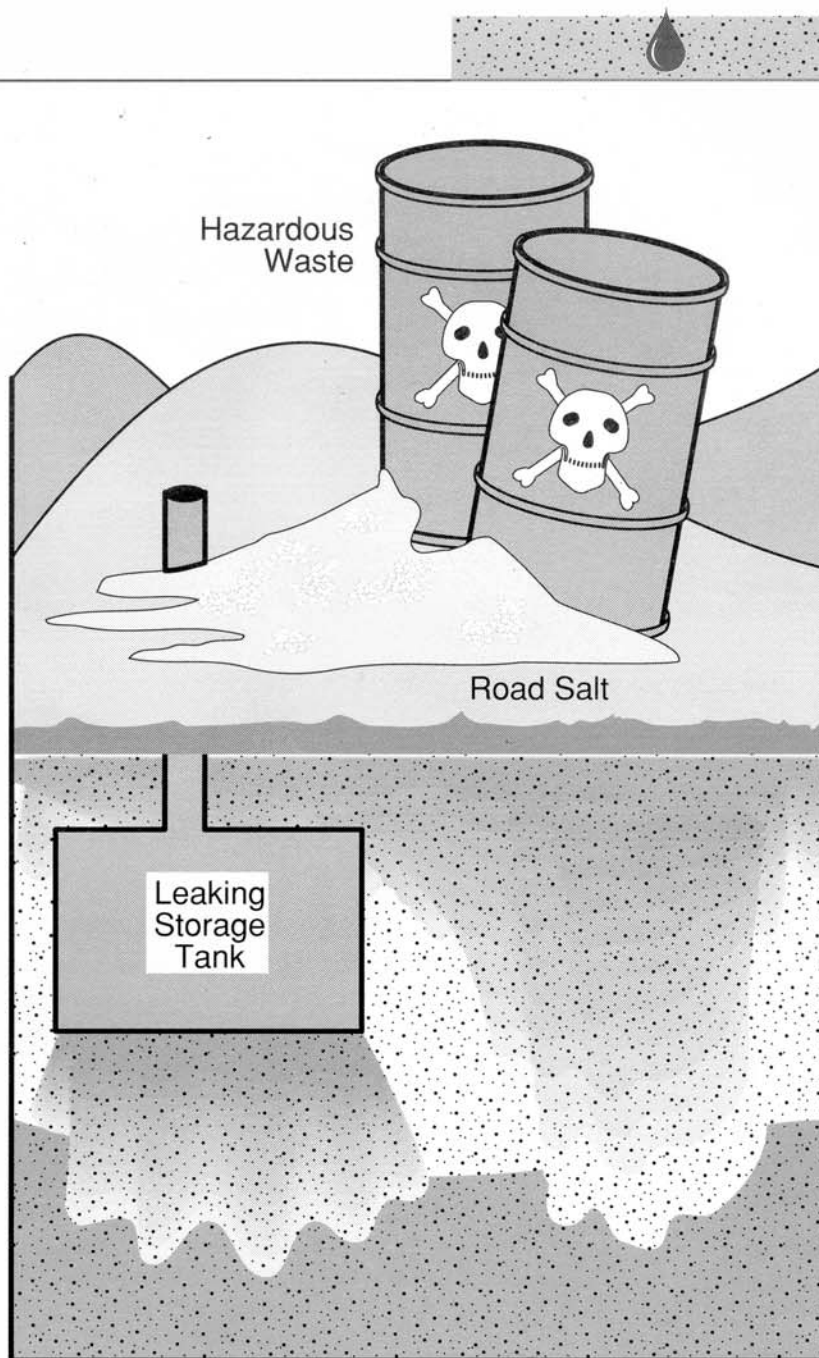
- ❖ leaking underground petroleum pipes and tanks
- ❖ use and storage of road salt
- ❖ improper use, disposal and storage of hazardous materials
- ❖ improper disposal of solid waste
- ❖ practices such as over-application of fertilizers and pesticides
- ❖ improper management of animal wastes

Since groundwater flow is generally slow, pollution may take decades to show up in a well, lake or stream. Removal of contaminants is expensive and difficult (if not impossible), so **prevention** of contamination is the key to maintaining groundwater quality.

How Can You Help?

There are many things you can do to help protect Wisconsin's buried treasure:

- ❖ Become more aware of groundwater use in your area and how everyday actions can affect groundwater.
- ❖ Conserve water in your home. Don't allow the water to run while you wash the car, do dishes or brush your teeth. Take shorter showers (each minute of a shower uses 10 gallons of water), water



lawns and gardens before 10 am or after 6 pm to reduce evaporation loss.

- ❖ Become involved in community waste disposal problem solving.
- ❖ Recycle aluminum, tin, paper, newsprint and plastic containers.
- ❖ Make sure your well is properly located, constructed and maintained. Test your well annually for bacteria and nitrate levels.
- ❖ Make sure your septic system is properly located, constructed and maintained.
- ❖ Become aware of alternatives to using hazardous household chemicals.

- ❖ Follow recommended procedures for using, storing and disposing of household chemicals.

- ❖ If you use pesticides and fertilizers, apply them in recommended amounts.
- ❖ Report illegal or abandoned waste sites.
- ❖ Report incidents of improper waste disposal or chemical spills.
- ❖ Attend public meetings and correspond with government officials on groundwater management issues.

We should all treat water as if our lives depend on it—they do!

Note: Words that appear in italic are defined in the glossary.



Buried Treasure

Wisconsin's groundwater would cover the state's 36 million acres 30 feet deep

more than 70% of us drink groundwater

There are more than 700,000 private or municipal wells in Wisconsin

Wisconsin industries use 614 million gallons of water/day

Livestock farms use 89 million gallons of water/day

Irrigation equipment extracts 84 million gallons of groundwater/day

Groundwater provides the base flow of most streams and rivers

Groundwater is the source of water for most lakes and wetlands

Leachate: A liquid formed by water percolating through soluble waste material. Leachate from a landfill has a high content of organic substances and dissolved minerals.

Limestone: A sedimentary rock consisting chiefly of the mineral calcite (calcium carbonate).

Permeability: The capacity of soil or rock to transmit a fluid, usually water.

pH: From the phrase p(otential) of H(ydrogen), pH is a measure of acidity or alkalinity. As a solution becomes more acidic, its pH decreases; as it becomes less acidic its pH increases. A solution with a pH of 7 is considered neutral; a pH less than 7 is acidic and a pH greater than 7 is considered alkaline.

Sanitary landfill: A specially engineered site for disposing solid waste on land. Constructed in a way that reduces hazards to health and safety.

Solid waste: All solid and semi-solid wastes, including trash, garbage, yard wastes, ashes, industrial waste, swill, demolition and construction waste and household discards such as appliances, furniture and equipment.

Spring: A natural discharge of water at the ground's surface.

Static water level: The elevation above sea level of the surface of water in monitoring wells. Used to determine the direction of groundwater flow.

Transpiration: The release of water vapor and waste products through the pores (stomata) of plants.

Volatile Organic Chemicals (VOCs): a group of commonly used chemicals that evaporate, or "volatilize" when exposed to air.

Water table: The level below which the soil or rock is saturated with water. The upper surface of the saturated zone.

Well: A vertical excavation that taps an underground formation; in Wisconsin, usually to obtain a source of water, to monitor the quality of groundwater or to determine the elevation of the water table.

Glossary

Aquifer: A rock or soil layer capable of storing, transmitting and yielding water to wells.

Artesian: A condition referring to groundwater that is under enough pressure to rise above the aquifer containing it. Sometimes artesian wells will flow at the surface.

Coliform bacteria: A group of bacteria found in animal feces or sewage whose presence in well water may indicate contamination carried by surface water to groundwater. Water containing high levels of coliform bacteria should not be consumed.

Dolomite: Calcium magnesium carbonate, a common rock-forming mineral. Many rocks in Wisconsin generally referred to as limestone are actually dolomite.

Dump: An open, unsanitary disposal site used before the existence of licensed, controlled sanitary landfills. Opening a dump is now illegal in Wisconsin.

Evaporation: The process by which water is changed from a liquid or solid into a vapor.

Groundwater: Water beneath the surface of the ground in a saturated zone.

Hazardous waste: Waste that causes special problems for living organisms or the environment because it is poisonous, explosive, dissolves flesh or metal, ignites easily (with or without a flame) or carries disease.

High capacity well: A well that withdraws more than 100,000 gallons of water per day.

Hydrologic or water cycle: The complete cycle of phases through which water passes from the atmosphere to the earth and back to the atmosphere.

Impermeable: Having a texture that does not permit water to move through quickly.

Infiltration: The movement of water into and through soil.

How many gallons of water does it take to produce:

- | | |
|--------------------------------|---------------------------------|
| ❖ a steak? . . . 3,500 | ❖ a car? . . . 30,000 |
| ❖ 20 lb turkey? . . . 16,300 | ❖ a gallon of gasoline . . . 70 |
| ❖ an egg? . . . 120 | ❖ a ton of paper? . . . 32,000 |
| ❖ a ton of steel? . . . 60,000 | |